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# POWER SUPPLY DEVICE

Background Information

The present invention relates to power supply devices, in particular in vehicle electricelectrical systems according to the preamble of Patent Claim 1.

Traditional power supply devices in motor vehicles have a generator, a battery, and various electricelectrical consumers of the vehicle electricelectrical system. The generator is driven by the internal combustion engine of the vehicle via suitable connecting means, e.g., the belt drive, and supplies the electricelectricity required to charge the battery and supply power to the consumers. The output voltage of the generator is regulated to the desired level by an assigned voltage regulator and/or generator regulator, actual output voltage U1 of the generator optionally being varied within certain limits and adapted to preselectable requirements.

The generators customarily used are separately energized three--phase generators having an excitation winding through which flows an excitation current flows that is supplied by the battery and is switched by the generator regulator after activation of the ignition switch of the vehicle ("ignition on"). In order for a generator to be able to "start" at all, it needs the excitation current from the battery in the start phase. The excitation current creates a magnetic field in the rotor of the generator, thereby inducing a voltage in the stator winding of the generator when the rotor is rotating.

Since vehicle electricelectrical systems need different voltages to supply the various electricelectrical consumers, motor vehicles are known to use power supply devices that include multiple voltage systems at different voltages. Such an automotive power supply device is known from DE 38 12 577 A1, for example, and includes two generators supplying voltages U1 and U2 to charge storage devices, i.e., batteries, and the assigned electricelectrical consumers of the vehicle electricelectrical system. Each generator is assigned its own battery. There is no provision for complete decoupling of the individual voltage systems.

Another power supply for a vehicle electricelectrical system using two generators is known from DE 101 06 723, in which a PWM inverter is provided for each generator

designed as a three--phase generator having an excitation winding and stator windings, a connection to one battery at a time being establishable via this PWM inverter. The generators supply different output voltages via which two partial vehicle electricelectrical systems are supplied with power. No details are given about the start phase of the generators.

Object of the Invention

With complete decoupling of the individual voltage systems, in particular two systems, the second generator does not have the excitation current required for starting. When using only one battery in particular, the second generator, i.e., the generator that is decoupled from the battery, does not have the excitation current required for starting. Therefore, the object of the present invention is to find a solution to this problem and ensure that after actuation of "ignition on," the second generator will also receive a sufficiently high excitation current that will allow it to be started reliably. This object is achieved by a power supply device having the features of Patent Claim 1.

Advantages of the Invention

The power supply device according to the present invention as recited in Claim 1 has the advantage that the excitation current required for starting is reliably supplied to the second generator, thereby ensuring complete functionality of the two generators. This advantage is achieved by providing additional connection options in the form of connecting means between the excitation winding of the second generator and a charge storage device, these means being switched at least temporarily so that a conducting connection is established. The conducting connection is advantageously begun with the operation of the ignition switch and is maintained until the generator has started and is generating an output current. In particular an additional connection is established between the voltage system together with the battery and the second generator, which does not belong to this voltage system.

Additional advantages of the present invention are achieved by the measures characterized in the subclaims.

It is advantageous in particular to establish the additional connection via a voltage transformer, which is advantageously designed as a bidirectional d.c./d.c. transformer and is thus able to conduct power in both directions and equalizes voltage differences prevailing in the two voltage systems, i.e., adjusts the voltages. It is then possible for two generators to supply power to the voltage system including the battery. The excitation current required for the second generator is supplied "in reverse" from the battery via the d.c./d.c. transformer.

In another advantageous embodiment of the present invention, the additional connection is established by a diode, using, if necessary, additional components, in particular a resistor. This has the advantage that decoupling is obtained when there is a low generator voltage on the second generator, whereas under the condition that the voltage of the second generator is higher than the voltage of the first, there is again decoupling of the two voltage systems. Advantageously, this does not require separate switching means.

In another advantageous embodiment of the present invention, the additional connection is established by a switch, either a relay or an electronic switch, advantageously a transistor switch. At "ignition on," the switch is closed and the connection to the battery is established, so that an excitation current may also flow in the second generator. After ramp--up of the second generator, the switch is opened again and the two voltage systems are again decoupled from one another. One of the two voltage systems may be advantageously supplied with power by both generators in parallel operation of the two generators, in which case the two generators are required to have the same output voltage.

If a generator regulator having a sense path to the first voltage system, i.e., vehicle electricelectrical system, is used for the second generator, the excitation current for starting the second generator may flow over this sense path. In addition, a preselectable degree of coupling of the two voltage systems via an internal wiring of the sense path to the regulator may be established in an advantageous manner.

In another advantageous embodiment of the present invention, the excitation current for starting up the second generator is obtained from an additional charge storage

device which is part of the second voltage system and is designed as an extra battery, a capacitor or a SuperCap, for example. Complete decoupling of the two voltage systems, i.e., vehicle electricelectrical systems, is then possible.

Drawing

Five exemplary embodiments of the present invention are illustrated in Figures 1 through 5 and are explained in greater detail in the following description.

Description

Figure 1 shows a first exemplary embodiment of the present invention. A first generator G1, e.g., an externally regulated three--phase generator, is connected at the voltage end to the charge storage device, i.e., battery B1, and charges it during normal operation. Generator G1 and battery B1 also have a ground connection in the usual manner. Consumers V1 may be connected to battery B and/or generator G1 via ignition switch Z and any other switches S1 that are provided, if necessary. In addition to stator windings (not shown), generator G1 also includes an excitation winding E1 and a voltage regulator, i.e., generator regulator R1, which regulates the excitation current flowing through excitation winding E1 in a known way and thus regulates desired output voltage U1 of generator G1. These elements constitute a first voltage system, i.e., vehicle electricelectrical system.

In addition, a second generator G2 having its own voltage regulator R2 and an excitation winding E2 is also present, this generator being used to supply power to consumers V2 which may be turned on or off via switches S2. The output voltage of generator G2 is regulated to a voltage U2 by voltage regulator R2. Switch S2, consumer V2, and generator G2 having excitation winding E2 and voltage regulator R2 form a second voltage system, i.e., vehicle electricelectrical system, which is decoupled from the first voltage system, i.e., vehicle electricelectrical system.

An additional connection between the two voltage systems, i.e., vehicle electricelectrical systems, is established via a voltage transformer W, which is made possible by the approach according to the present invention. Without this additional connection, second generator G2 would not have excitation current IE2, which is

required for starting, through excitation winding E2 with complete decoupling of the two voltage systems and the generator would not be able to start.

By coupling the two voltage systems via the additional connection by a voltage transformer W, excitation current IE required for starting may be supplied to generator G2 from battery B1. Excitation current IE2 required for second generator G2 is supplied in "reverse" via d.c./d.c. transformer W from battery B1. First generator G1, i.e., its excitation winding E1, is connected to battery B1 in the usual manner after operation of the ignition switch, so that an excitation current IE flows and allows the starting operation of generator G1.

Voltage transformer W, designed as a bidirectional d.c./d.c. transformer, for example, which is thus capable of delivering power in both directions and equalizes voltage differences prevailing in the two voltage systems, i.e., adjusts the voltages, also makes it possible to supply power to the first voltage system, which includes battery B1, via two generators G1 and G2. In the exemplary embodiment according to Figure 1, a dual--voltage vehicle electricelectrical system may be created, having U1 = – 12 V and U2 = 36 V, for example, each in nominal voltage or U1 = 14 V and U2 = 42 V.

Figure 2 shows another exemplary embodiment of the present invention. It includes the same components as in the exemplary embodiment according to Figure 1 except for voltage transformer W. The additional connection between the two voltage systems and thus the coupling of the two voltage systems are established via a diode D and optionally a resistor Wi and other components, if necessary. Diode D is installed in such a way that the cathode is connected to generator G2 and the anode is connected to generator G1, so that the diode is able to conduct a current from battery B1 to excitation winding E2 if no voltage has been induced in generator G2. The excitation current necessary for starting is supplied from battery B1 to second generator G2 via this connection.

At a low generator voltage UG2 of second generator G2, a connection of the second voltage system to the first is established, while under the condition that voltage UG2 of second generator G2 is higher than voltage UG1 of first generator G1, there is

again decoupling of the two voltage systems, so to speak, because diode D is nonconducting when UG2 > UG1. It is advantageous that separate switching means are not required here.

Figure 3 shows a third exemplary embodiment of the present invention. Except for the voltage transformer, it includes the same components as the exemplary embodiment according to Figure 1. The additional connection between the two voltage systems and thus excitation winding E2 of generator G2 to battery B1 is established via a relay or a switch S3 by which excitation current IE2 needed for starting is then supplied.

Switch S3 may also be an electronic switch, advantageously a transistor switch. At "ignition on," switch S2 is closed and the connection to battery B1 is established, so that an excitation current IE2 is also able to flow in second generator G2. After ramp--up of second generator G2, switch S3 is opened again and the two voltage systems are decoupled from one another again. One of the two voltage systems, in particular the first, may advantageously be supplied with power by both generators in the case of parallel operation of two generators G1 and G2, in which case the same output voltage (U1 = U2) is then required of both generators G1 and G2, and switch S3 is closed. Switch S3 may be triggered via a control unit (not shown), for example.

Figure 4 shows a fourth exemplary embodiment of the present invention. Except for the voltage transformer, it includes the same components as the exemplary embodiment according to Figure 1. The additional connection between the two voltage systems and thus excitation winding E2 of generator G2 to battery B1 is accomplished via a relay or a sense path SP via which excitation current IE2 needed for starting is then supplied. The prerequisite for this embodiment is that generator regulator R2 of generator G2 has a sense path SP to the first voltage system, i.e., vehicle electricelectrical system. For example, voltage information is also relayed over such a sense path. The internal wiring of sense path SP is responsible for the degree of coupling of the two voltage systems.

Figure 5 illustrates a fifth exemplary embodiment of the present invention. Except for the voltage transformer, it includes the same components as the exemplary

embodiment according to Figure 1. However, there is no additional connection between the two voltage systems and thus excitation winding E2 of generator G2 to battery B1, so that there is complete decoupling of the two voltage systems. The required excitation current for starting generator G2 is supplied by an extra battery ZB in the second voltage system. A capacitor or a SuperCap may also be used as the extra battery.

At least to a certain extent, these exemplary embodiments may also be combined with one another with appropriate circuit adjustments.